Mixed-Criticality Systems with Partial Lockdown and Cache Reclamation Upon Mode Change

CISTER – Research Centre in
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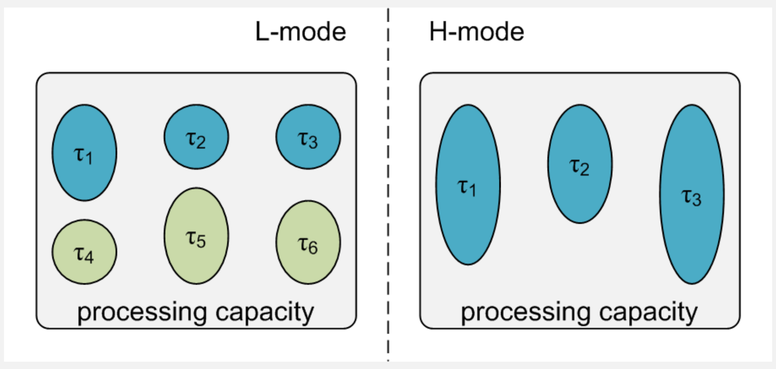
1) The classic Vestal model

- In each mode, tasks of a certain criticality or higher execute.
- Different WCET estimates for the same task in different modes.
    - By techniques with corresponding confidence levels.
- When a task would overrun its WCET estimate for that mode, a mode change occurs (e.g., **L** ⟶ **H**, with two modes).
- Essentially, the processor resources intended for the L-tasks are repurposed for the H-tasks upon mode change.



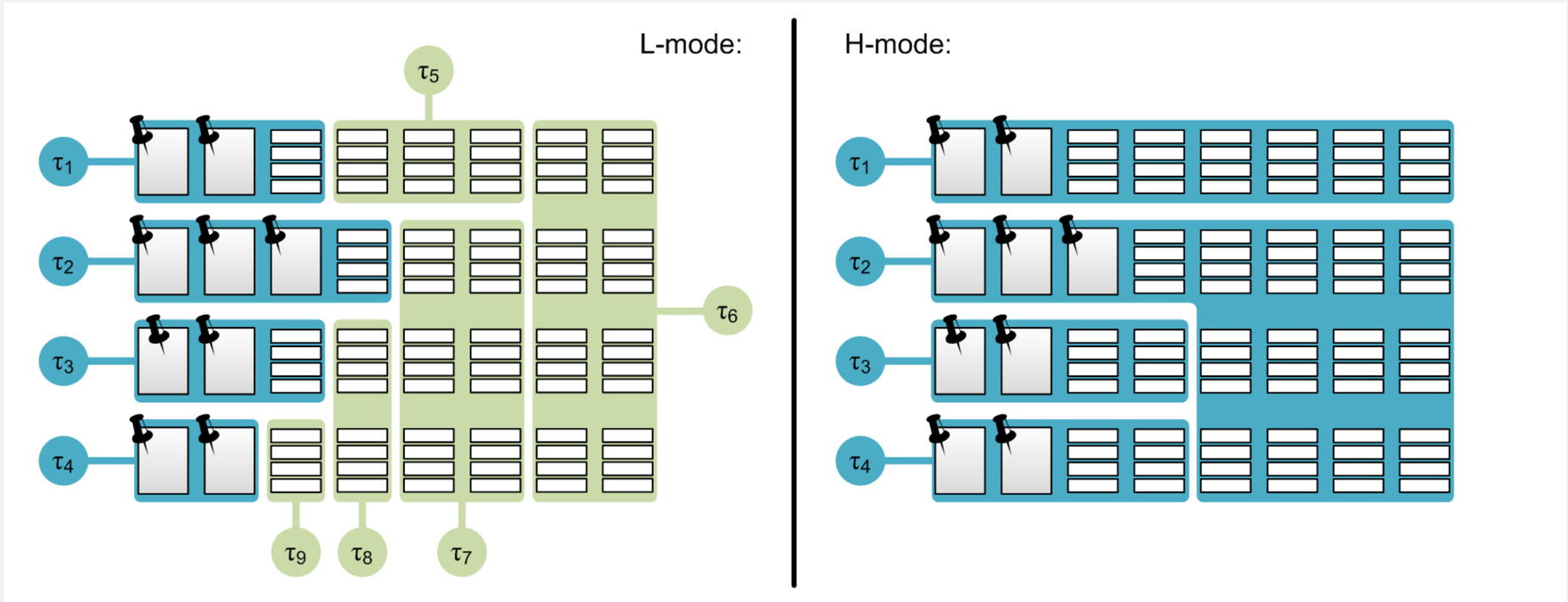
2) Extending the principle to additional resource types

- **Idea**: Reclaim more kinds of resources at mode change!
- Explored by our paper at the ECRTS 2017 main track, for the shared last-level cache of a multicore.
    - Per-task cache partitions reconfigured at mode change.

    .
- This work-in-progress explores a more refined arrangement:
    - Partial use of H-task partitions for locked hot pages.
    - The rest of the cache partitions is populated dynamically (e.g., LRU).

- WCET estimates become functions of:
    - Analysis technique for each mode (L, H);
    - Size (σ) of task partition for locked hottest pages;
    - Size (π) of task partition used dynamically.

3) Illustration of the arrangement and reconfiguration



4) Lockdown vs dynamic use

- Locking of hot pages in cache: more predictable task execution.
- Dynamic cache partition use: *might* lower the *actual* WCET but makes analysis more complicated – possibly requiring pessimistic simplifying assumptions.
- Different tradeoffs for static WCET analysis (H-mode estimates) vs probabilistic measurement-based (L-mode estimates).
- No page locking in L-task cache partitions, in order to minimise reconfiguration overheads at mode change.

5) Some challenges

- Accurate and tractable parametric WCET estimation for many points (σ,π) per task in the design space.
- Identification of good heuristics for partitioning the cache in the two modes.
- Estimation of reconfiguration overhead from the task partition parameters and incorporation to schedulability test for EDF with deadline-scaling.

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